DESCRIPTION

REPRODUCING APPARATUS AND RECORDING MEDIUM

TECHNICAL FIELD

This invention relates to a disk-shaped recording medium into which a user is able to record a data signal and to a reproducing apparatus for reproducing main data recorded on such a recording medium.

BACKGROUND ART

As one type of conventional mass-storage recording medium, there are optical disks known as DVDs (Digital Video Disks or Digital Versatile Disks). A DVD-ROM (Read Only Memory) is a reproduction-only type optical disk on which video and audio data of a movie, music, and the like and data such as representing a computer program have been recorded at the time of its manufacture. A DVD-R (Recordable) is a write-once type optical disk onto which a user is able to record a data signal. In the following description, the DVD-ROM is referred to as a ROM disk and the DVD-R is referred to as an R disk.

If copying of main data recorded on a ROM disk into an R disk is free to carry out, this may cause various problems against copyright laws. Generally, to provide a copy protection scheme, at the time of the manufacture of a ROM disk its main data is encrypted before being recorded in a primary recording region of the ROM disk and key information for decrypting encryption of the main data is recorded in a secondary recording region of the ROM disk located on the

side of an internal periphery of the primary recording region. In addition, it is possible to take other countermeasures against unauthorized copying. For example, at the time of the manufacture of an R disk, invalid key information is recorded in a secondary recording region of that R disk and identification information indicating that the disk concerned is not a ROM disk but an R disk is recorded also in the secondary recording region. However, these copy protection schemes are considered not to be thoroughgoing. If encrypted main data on a ROM disk is copied into a primary recording region of an R disk, together with its control information including a key information item and an identification information item indicating that the disk concerned is a ROM disk, it is likely that the copied main data is reproduced by the use of the copied control information in a conventional DVD reproducing apparatus. This is due to the fact that if false control information exists in a primary recording region of an R disk this causes a conventional DVD reproducing apparatus to mistakenly accept such control information prior to seeking out genuine control information in a secondary recording region of the R disk.

DISCLOSURE OF INVENTION

Accordingly, an object of the present invention is to make it possible to ignore, even when false control information is copied into a primary recording region of a recording medium into which a user is able to record data signals, such false control information, for seeking out

genuine control information in a secondary recording region of the recording medium.

In order to accomplish the object, the present invention provides a disk-shaped recording medium which comprises a primary recording region and a secondary recording region which is located on the side of an internal periphery of the primary recording region. The primary recording region has a track which wobbles at a first pitch, and along which a user is able to record a data signal. On the other hand, the secondary recording region has a track which wobbles at a second pitch different from the first pitch or does not wobble, and along which a signal representative of control information is already prerecorded at the time of the manufacture of the recording medium. Preferably, the control information in the secondary recording region includes an invalid key information item for inhibiting, when encrypted main data is copied into the primary recording region, reproduction of the main data. Further, it is preferred that the control information in the secondary recording region includes an identification information item representative of the type of the recording medium.

Further, the present invention provides a first reproducing apparatus for the reproduction of main data recorded in the primary recording region with a wobbling track of the foregoing recording medium, the reproducing apparatus comprising means for spinning the recording medium at a constant linear velocity; a pickup for reading a signal

from the recording medium under rotation; means by which a signal read position by the pickup follows a track of the recording medium; means for generating a tracking error signal from an output of the pickup; means for shifting the pickup in a direction toward an internal periphery of the recording medium until the pickup reaches a specific point of the secondary recording region at which the tracking error signal no longer contains a signal component having a frequency which is determined by the first pitch relating to the wobbling of the track in the primary recording region and the constant linear velocity, so that even when false control information is copied into the primary recording region the false control information is ignored; and means for starting reproduction of the main data recorded in the primary recording region according to the control information in the secondary recording region represented by an output of the pickup shifted to the point of the secondary recording region.

Further, the present invention provides a second reproducing apparatus capable of providing an effective copy protection scheme even when a recording medium without a wobbling track in its primary recording region is mounted thereto. The second reproducing apparatus, which is for reproducing, from a disk-shaped recording medium comprising (a) a primary recording region into which a user is able to record a data signal and (b) a secondary recording region which is located on the side of an internal periphery of the primary recording region and into which a signal

representative of control information is already prerecorded at the time of the manufacture of the recording medium, main data recorded in the primary recording region, comprises a pickup for reading a signal from the recording medium; means for shifting the pickup in a direction toward an internal periphery of the recording medium until the pickup reaches its shift limit point; and means for starting reproduction of the main data recorded in the primary recording region according to the control information in the secondary recording region obtained finally from an output of the pickup during shifting of the pickup, so that even when false control information is copied into the primary recording region the false control information is ignored.

According to the first and the second reproducing apparatus of the present invention, even when false control information is copied into a primary recording region of a recording medium into which a user is able to record data signals, it is possible to seek out genuine control information in a secondary recording region of the recording medium. This provides an effective copy protection scheme. For example, control information in the secondary recording region includes an invalid key information item for inhibition of reproduction of encrypted main data, so that when main data copied and recorded in the primary recording region is encrypted its reproduction can be canceled according to the invalid key information item. Further, control information in the secondary recording region

includes an identification information item representative of the type of the recording medium, so that when the identification information item indicates that recording of a data signal into the primary recording region by a user is possible and, in addition, main data recorded in the primary recording region is encrypted, it is possible to cancel reproduction of the main data. However, in the case main data recorded in the primary recording region is not encrypted, it is possible to continue reproduction of the main data.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a perspective view of an optical disk showing one example of a recording medium according to the present invention.

Figure 2 is a partly enlarged plan view of a track in a primary recording region in Figure 1.

Figure 3 is a partly enlarged plan view of a track in a secondary recording region in Figure 1.

Figure 4 is a diagram showing a variation of Figure 3.

Figure 5 is a circuit block diagram showing a construction example of a DVD reproducing apparatus according to the present invention, with an optical disk of Figure 1 mounted thereto.

Figure 6 is a waveform diagram of a tracking error signal when the primary recording region in Figure 1 is being scanned with a light beam.

Figure 7 is a conceptual diagram showing one example of a data structure in the optical disk of Figure 1.

Figure 8 is a circuit block diagram showing a construction example of another DVD reproducing apparatus of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Embodiments of the present invention will be described with reference to the accompanying drawings.

Figure 1 shows an optical disk which is one example of a recording medium according to the present invention. The optical disk 10 of Figure 1 is a DVD-R, i.e., an R disk. The optical disk 10 comprises a clamping region defined around the periphery of a center hole of the optical disk 10 and, in an area of the optical disk 10 not occupied by the clamping region, a primary recording region 20 and a secondary recording region 30 located on the side of an internal periphery of the primary recording region 20.

Figure 2 is a partly enlarged plan view of a track in the primary recording region 20 in Figure 1. The primary recording region 20 has a track 21 formed of a groove which wobbles at a pitch P1, and a user is able to record a data signal by formation of information pits 22 along the track 21. The degree of wobbling of the track 21 can be expressed by the number of wobbles (N) with respect to a prescribed track length (L). For example, the number of wobbles is eight for a prescribed track length of 218.7 μm. In other words, the pitch P1 of the track 21 is about 27.3 μm.

Figure 3 is a partly enlarged plan view of a track in the secondary recording region 30 in Figure 1. The secondary recording region 30 has a track 31 formed of a groove which wobbles at a pitch P2 different from the wobble pitch P1 of the track 21 in the primary recording region 20, and information pits 32 are formed along the track 31 to record a signal representative of control information at the time of the manufacture of the R disk 10. The control information in the secondary recording region 30 includes an invalid key information item for inhibiting, when encrypted main data is copied into the primary recording region 20, reproduction of the main data and an identification information item indicating that the disk 10 is an R disk. In the example shown in Figure 3, the wobble pitch P2 of the track 31 is set greater than the wobble pitch P1 of the track 21.

Reference is now made to Figure 4 which shows a variation of Figure 3. It suffices for the track 31 in the secondary recording region 30 to be distinguishable from the wobbling track 21 in the primary recording region 20, so that the track 31 does not necessarily have to wobble, as not all of the tracks in a DVD-ROM (i.e., a ROM disk) wobble.

Figure 5 is a circuit block diagram illustrating an construction example of a DVD reproducing apparatus according to the present invention with the R disk 10 of Figure 1 mounted thereto. As will be described later, a ROM disk may be mounted to the DVD reproducing apparatus of Figure 5 instead of the R disk 10.

The DVD reproducing apparatus of Figure 5 comprises a spindle motor 41 for spinning the R disk 10, an optical pickup 42 for scanning the R disk 10 under rotation with a light beam and reading a signal from the R disk 10, and a slider 43 for shifting the optical pickup 42 in the radial direction of the R disk 10. The apparatus of Figure 5 further includes an amplifier 50, a mechanism controller part 60, a wobble detector circuit 70, a demodulator circuit 80, and a system controller circuit 90. The mechanism controller part 60 is constructed of a rotary servo circuit 61, a shift controller circuit 62, a tracking servo circuit 63, and a focus servo circuit 64.

The rotary servo circuit 61 controls the number of revolutions of the spindle motor 41 according to instructions from the system controller circuit 90 so that the R disk 10 spins at a constant linear velocity (CLV). The shift controller circuit 62 controls the slider 43 according to instructions from the system controller circuit 90 so that the optical pickup 42 is shifted in the radial direction of the R disk 10. The amplifier 50 amplifies an output of the optical pickup 42. In addition to this, the amplifier 50 has a function of performing addition/subtraction operations on a plurality of sensor signals forming an output of the optical pickup 42 thereby to generate a tracking error signal Ste and a focus error signal Sfe and a function of binarizing a modulated output of the optical pickup 42 thereby to generate a data detection signal Sdt. The tracking error signal Ste is

provided to the tracking servo circuit **63** and to the wobble detector circuit **70**, the focus error signal Sfe is provided to the focus servo circuit **64**, and the data detection signal Sdt is provided to the demodulator circuit **80**. The tracking servo circuit **63** controls the optical pickup **42** so that the position at which the optical pickup **42** reads a signal (i.e., the light beam irradiation point) follows the tracks **21** and **31** of the R disk **10**, thereby to reduce the tracking error signal Ste. The wobble detector circuit **70** detects a signal for a frequency component which is contained in the tracking error signal Ste due to the wobbling of the track **21** and/or the track **31** and the detection result is sent to the system controller circuit **90**. The focus servo circuit **64** controls vertical movement of the optical pickup **42** so that a light beam is focused to the R disk **10**, thereby to reduce the focus error signal Sfe. The demodulator circuit **80** is a circuit operable to demodulate the data detection signal Sdt to obtain main data and control information. The control information thus obtained is sent to the system controller circuit **90**. The system controller circuit **90** is a circuit operable to control the entirety of the DVD reproducing apparatus of Figure **5**.

Figure **6** is a waveform diagram of the tracking error signal Ste when the primary recording region **20** in Figure **1** is being scanned with a light beam. The tracking error signal Ste contains a signal component having a wobble frequency F1 according to the wobble pitch P1 of the track **21** in the

primary recording region **20**. This is because the frequency characteristic of the tracking servo circuit **63** is set such that the tracking servo circuit **63** does not have a gain sufficient enough to enable the light beam to follow the wobbling track **21** at the wobble frequency F1. The wobble frequency F1 can be defined by the number of wobbles per second when the wobbling track **21** is scanned at a constant linear velocity V, as expressed below.

$$F1 = (N/L) \times V = V/P1$$

In other words, the wobble frequency F1 is determined by the wobble pitch P1 of the track **21** and the constant linear velocity V. Here, if V = 3.84 m/s, then F1 = 140 kHz for the above-described example (in which L = 218.7 μm and N = 8).

The tracking error signal Ste when the secondary recording region **30** is being scanned with a light beam contains a signal component having a wobble frequency F2 lower than the wobble frequency F1 if the track **31** in the secondary recording region **30** wobbles at the pitch P2 (P2 > P1) as shown in Figure **3**. If the track **31** in the secondary recording region **30** does not wobble as shown in Figure **4**, this enables the light beam to accurately follow the track **31** and, as a result, the tracking error signal Ste becomes zero.

The system controller circuit **90** in Figure **5** issues instructions to the shift controller circuit **62**, thereby to make it possible to shift the optical pickup **42** in a direction toward an internal periphery of the R disk **10** until

the optical pickup **42** reaches a specific point of the secondary recording region **30** at which the tracking error signal Ste no longer contains a signal component having the wobble frequency F1, so that even when false control information is copied into the primary recording region **20** such false control information is ignored. Further, the system controller circuit **90** issues instructions to the demodulator circuit **80**, thereby to make it possible to start, according to control information in the secondary recording region **30** represented by an output of the optical pickup **42** shifted up to the point of the secondary recording region **30**, reproduction of main data recorded in the primary recording region **20**. In the case main data recorded in the primary recording region **20** of the R disk **10** is not encrypted, reproduction of the main data will continue, so that the main data recorded on the R disk **10** can be reproduced by the DVD reproducing apparatus of Figure **5**.

Reference is now made to Figure **7** which shows one example of a data structure in the R disk **10** of Figure **1**. More detailedly, Figure **7** shows a state in which encrypted main data DATA-ROM on a ROM disk (not shown) is copied into the primary recording region **20** of the R disk **10** together with control information including a key information item KEY-ROM on the ROM disk and an identification information item ID-ROM indicating that the disk concerned is a ROM disk. As described above, the main data DATA-ROM, the false control information items KEY-ROM and ID-ROM are recorded along the

track **21** which wobbles at the pitch P1 in the primary recording region **20**. On the other hand, control information including an invalid key information item KEY-R for inhibition of reproduction of the copied main data DATA-ROM and an identification information item ID-R indicating that the disk **10** is an R disk is recorded at the time of the manufacture of the R disk **10**. These genuine control information items KEY-R and ID-R are recorded along the track **31** in the secondary recording region **30** which wobbles at the pitch P2 or does not wobble.

The operation of the DVD reproducing apparatus of Figure **5** with the R disk **10** having a data structure as shown in Figure **7** mounted thereto will be described. The initial position of the optical pickup **42** is the read position of the main data DATA-ROM. The initial position of the optical pickup **42** is the position where the rotary servo circuit **61**, the tracking servo circuit **63**, and the focus servo circuit **64** start operating. The system controller circuit **90** issues instructions to the shift controller circuit **62** so as to shift the optical pickup **42** in a direction toward the internal periphery of the R disk **10** until certain control information is found out. In this way, the optical pickup **42** arrives at the false control information items KEY-ROM and ID-ROM. However, the wobble detector circuit **70** detects a signal component having the wobble frequency F1 in the tracking error signal Ste and the detection result is sent to the system controller circuit **90**. As a result, the system

controller circuit **90** issues instructions to the shift controller circuit **62** so that the optical pickup **42** is further shifted toward the internal periphery of the R disk **10** until the next control information is found out. In this way, the optical pickup **42** finally arrives at the genuine control information items KEY-R and ID-R. The tracking error signal Ste at this point of time does not contain any signal component having the wobble frequency F1, so that these genuine control information items KEY-R and ID-R are accepted by the system controller circuit **90**. Thereafter, the system controller circuit **90** issues to the shift controller circuit **62** instructions so that the optical pickup **42** is shifted in a direction toward the external periphery of the R disk **10** to the location of the main data DATA-ROM.

It is possible to tell whether the main data is encrypted or not from a flag which is located at the head of each divided section of the main data. In the example shown in Figure **7**, the main data DATA-ROM is encrypted, so that the demodulator circuit **80** is unable to decrypt encryption of the main data even if the invalid key information item KEY-R is used. In other words, the system controller circuit **90** is able to cancel, when main data recorded in the primary recording region **20** is encrypted, reproduction of the main data by the demodulator circuit **80** according to the invalid key information item KEY-R. In this case, recording of the identification information item ID-R into the secondary recording region **30** may be omitted.

As described above, according to the DVD reproducing apparatus of Figure 5, it is possible to seek out genuine control information, even when an R disk having a primary recording region with false control information copied thereinto is mounted, or even when a conventional ROM disk is mounted. This provides an effective copy protection scheme and there is no interference with normal reproduction.

Reference is made to Figure 8 which illustrates a construction example of a DVD reproducing apparatus according to the present invention. In Figure 8, reference numeral 10 denotes an R disk having a primary recording region into which a user is able to record a data signal and a secondary recording region which is located on the side of the internal periphery of the primary recording region and into which a signal representative of control information is already prerecorded at the time of the manufacture of the R disk 10. The R disk 10 does not necessarily have a wobbling track in the primary recording region.

The DVD reproducing apparatus of Figure 8 is provided with a search controller circuit 75 in place of the wobble detector circuit 70 of Figure 5. The search controller circuit 75 issues to the shift controller circuit 62 instructions thereby to shift the optical pickup 42 toward the internal periphery of the R disk 10 until the optical pickup 42 reaches its shift limit point, for searching the R disk 10 for every control information recorded therein. That the optical pickup 42 is shifted to the shift limit point is

Further, the identification information item ID-R may be utilized for copy protection. That is to say, the system controller circuit **90** is able to cancel, when the identification information item indicates that the disk **10** concerned is an R disk and, in addition, the main data recorded in the primary recording region **20** is encrypted, reproduction of the main data by the demodulator circuit **80**. In this case, recording of the invalid key information item KEY-R into the secondary recording region **30** may be omitted.

As described above, it is possible to mount to the DVD reproducing apparatus of Figure **5** a ROM disk in place of the R disk **10**. Here, encrypted main data is recorded in a primary recording region of the ROM disk, and control information including a key information item for decrypting the encryption and an identification information item indicating that the disk concerned is a ROM disk is recorded in a secondary recording region of the ROM disk. However, none of the tracks in the primary and secondary recording regions wobbles. The DVD reproducing apparatus of Figure **5** facilitates seeking out genuine control information in the secondary recording region of the ROM disk. The tracking error signal Ste at this point in time does not contain any signal component having the wobble frequency F1, so that the genuine control information found out is accepted by the system controller circuit **90**. The demodulator circuit **80** is able to decrypt encryption of the main data by the use of the genuine key information.

detected by the system controller circuit **90**, for example, from the fact that a signal read by the optical pickup **42** stays unchanged. At this point in time, the system controller circuit **90** instructs the search controller circuit **75** not to conduct further searches. Further, it is arranged such that the system controller circuit **90** starts reproduction of the main data recorded in the primary recording region according to the control information in the secondary recording region obtained finally from an output of the optical pickup **42** during shifting of the optical pickup **42**, so that even when false control information is copied into the primary recording region of the R disk **10** such false control information is ignored.

According to the DVD reproducing apparatus of Figure **8**, as in the case of Figure **5**, even when an R disk having a primary recording region with false control information copied thereinto is mounted, or even when a conventional ROM disk is mounted, it is possible to seek out genuine control information. This provides an effective copy protection scheme and there is no interference with normal reproduction.

INDUSTRIAL APPLICABILITY

According to the present invention, even when false control information is copied into a primary recording region of a recording medium into which a user is able to record data signals, such false control information is ignored and genuine control information in a secondary recording region of the recording medium is found out. This accordingly

provides an improved DVD reproducing apparatus capable of providing an effective copy protection scheme.